

**Household Energy Program For Reduction of Exposure to Indoor Air  
Pollutants**

**Project Report No. 1**

By

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## **A. Background**

Right Track is a Kolkata, India based NGO working in both rural and urban areas to improve the living conditions of the poorer sections of the society by providing education. They are presently working in urban slum areas of Kolkata. Their objective is to provide improvement in quality of air, drinking water, sanitation using better technologies in an integrated project.

A survey conducted in the study area revealed that the children and women in these urban communities were having severe health problems due to poor indoor air quality, unsafe drinking water and poor sanitation system.

Poor indoor air required intervention to bring changes in cook stove and fuel used for the cook stove and better ventilation. It was understood that low cost and highly efficient cook stove would have a strong role in bringing about an improvement in the indoor air quality for these communities. One of the strong recommendations for the study was to involve local youth for production of low cost and highly efficient cook stove with the help of locally available materials. The logic behind the recommendation was that it would bring down the cost of the improved cook stove which are usually more expensive than the traditional stoves.

Right Track subcontracted Appropriate Rural Technology Institute (ARTI), Pune to undertake the 'Household Energy Program For Reduction of Exposure to Indoor Air Pollutants' in the slum areas of Kolkata, India. Dr Karabi Dutta was the project coordinator for the project.

Initially five slums of Kolkata, Howrah and 24 Parganas (South), West Bengal were identified for intervention. Most of these settlements are situated on the banks of river Ganga. Community youths both male and female who lived in these slums were inducted into the program as field workers. ARTI began the project by arranging an awareness camp for the community youth and Right Track staff to explain the benefits of improved

indoor air and impact of improved cooking stoves in improving the indoor air quality. Later the volunteers were provided a training in manufacturing improved stoves

### **B.1. Project Details**

**Sub Recipient:** Appropriate Rural Technology Institute (ARTI)

**Contracting Agency:** Right Track, Kolkata

**Funding Agency:** GOAL, India

**Date of 1<sup>st</sup> Progress Report:** 20<sup>th</sup> November, 2006

## **2. Report**

### **Task 1: Training on Stove construction and use**

**Training Venue:** SEED Anandadhara, Chunabhatti, Howrah, West Bengal.

**Organized by:** Right Track, Kolkata.

**Training In-charge:** Mr M.M. Shaikh from Appropriate Rural Technology Institute, Pune, India

**Training Assistant:** Mr P.P Kadam from Appropriate Rural Technology Institute, Pune, India

**Total no. of trainees:** 22

**Training was given on the following topics:**

- 1. Introduction to Moulds and types of moulds-Laxmi, Bhagyalaxmi, Grihalaxmi**
- 2. Composition of Clay for making stoves and methods of mixing clay and other ingredients**
- 3. Construction of clay models of Laxmi with moulds**
- 4. Construction of clay models of Bhagyalaxmi with moulds**
- 5. Construction of clay models of Grihalaxmi with moulds**

**Description of the stoves:** The improved vented *Laxmi* stove is a two pot stove with the combustion chamber directly below the first pot, and a smaller second pot connected to the first chamber via a duct. A second duct connects this chamber to the flue, which passes through the roof and vents to the outdoors. The *Bhagyalaxmi* does not have this second duct leading to the flue. The second pot hole has pot raisers. Both these stoves have grates below the fire box. The *Grihalaxmi* is single pot stove and has no flue but has two cast iron grates one below and one above the fire box. The pot hole has pot raisers.

**6. Practical by the trainees**

**7. Quenching Test of the cast iron grates.**

## **8. Training on Stove use and maintenance to users, community catalysts, and entrepreneurs.**

### **Task 2: Testing the Performace Of Traditional and Improved Stove models by Water Boiling Test.**

**Testing Venue: Community room of Right Track, Kolkata in Khalbari**

**Testing In-charge:** Mr M.M. Shaikh from Appropriate Rural Technology Institute, Pune, India

**Testing Assistant:** Mr P.P Kadam from Appropriate Rural Technology Institute, Pune, India

#### **Stove Models selected for testing:**

1. Traditional 1 Pot mud stove without chimney and without grate.
2. Traditional bucket Stove with mud lining
3. Traditional bucket Stove with cement lining
4. CPRI cast iron portable model
- 5.1 Pot Improved Stove without chimney but with iron Grate (Grihalaxmi)
6. 2 Pot Improved Stove with chimney and with iron Grate (Laxmi Model)

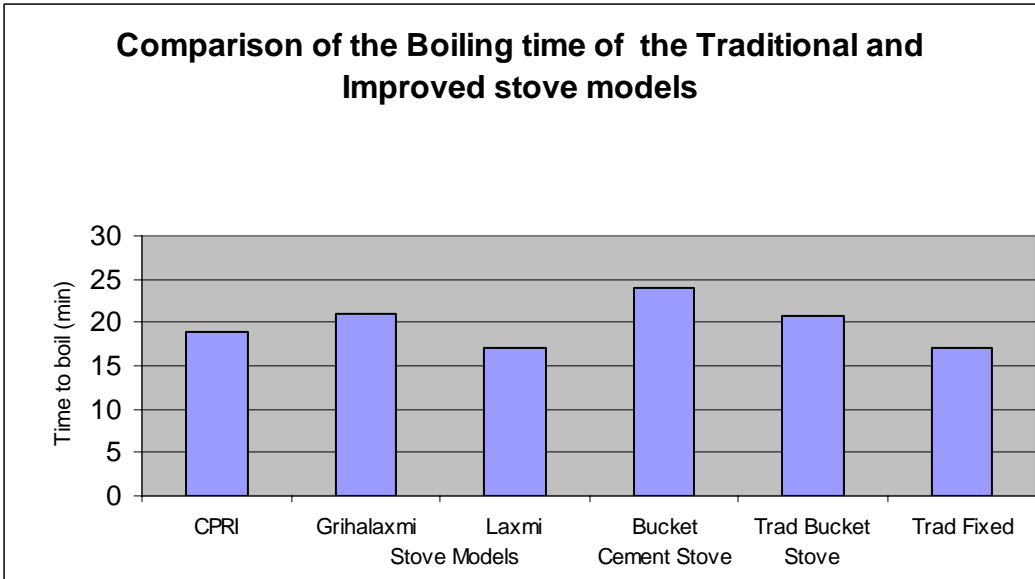
#### **Results:**

Water Boiling tests were carried out on the stove models mentioned above. The Aprovecho Institute along with University of California, Berkeley has standardized a methodology for this test. ARTI has followed this method of testing. The results of this test are represented in the graphs below. The instruments used for this test were provided to ARTI by UC, Berkeley. USA.

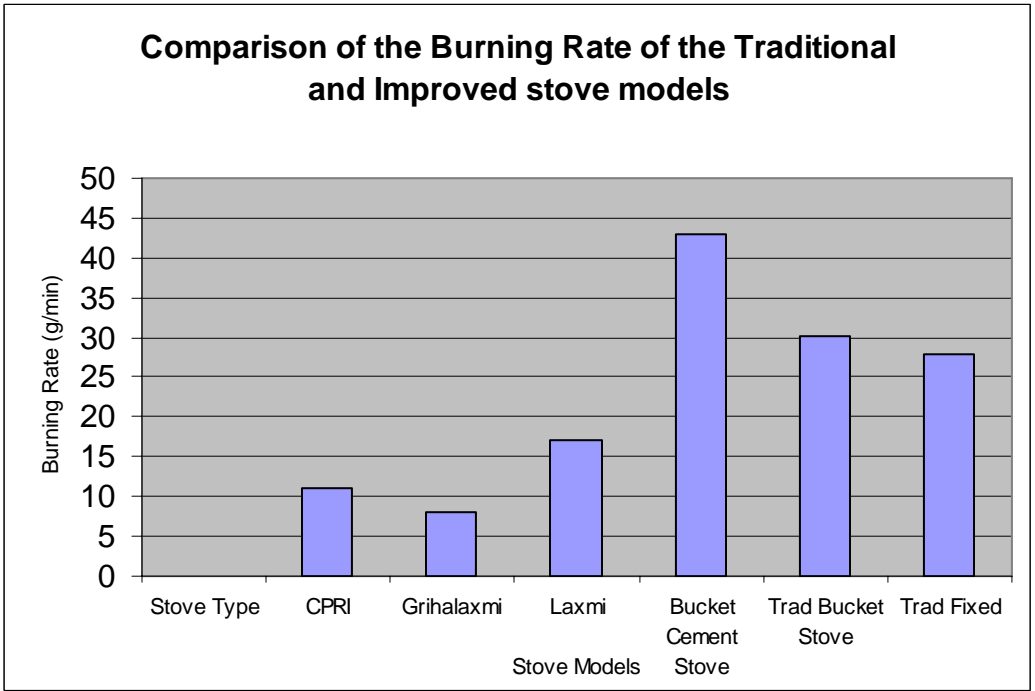
The bar graphs below show the comparative performances of the different stove types based on the Water Boiling Test Results.

The performance of the Grihalaxmi is similar to CPRI stove.

#### **Fig1: Comparison of the Boiling time**

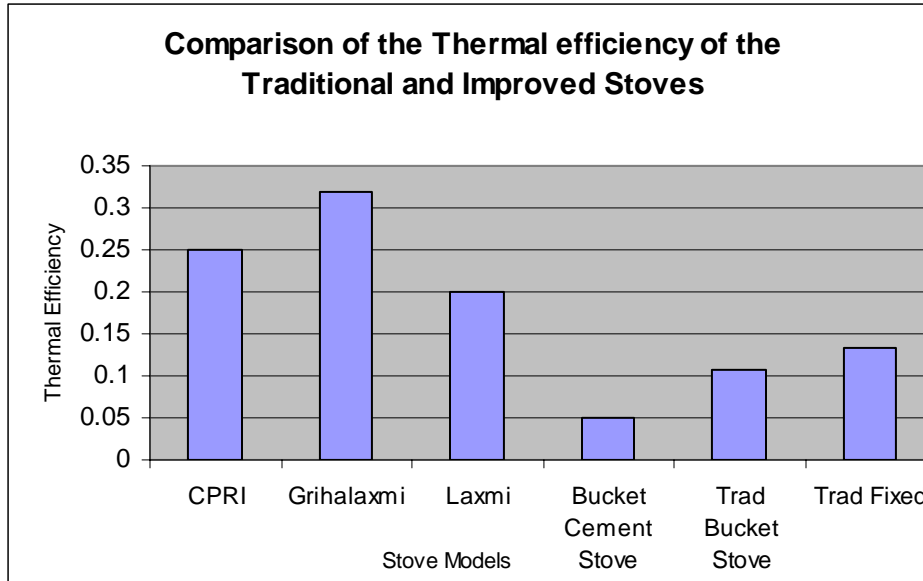


**Fig2: Comparison of the burning rate**



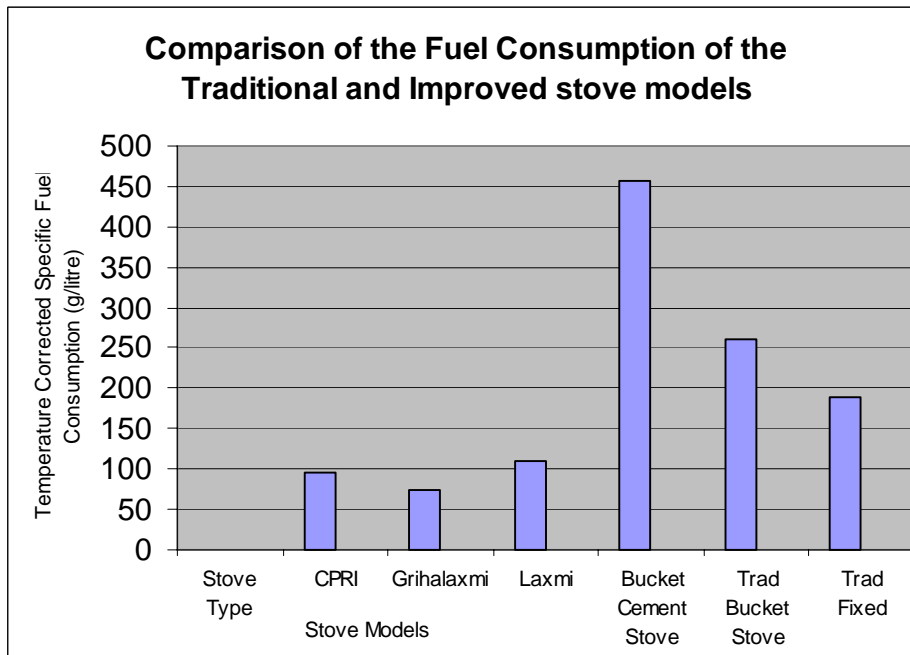
Burning rate= This is the measure of the rate of fuel consumption while bringing water to the boil.

**Fig3: Comparison of the Thermal Efficiency**



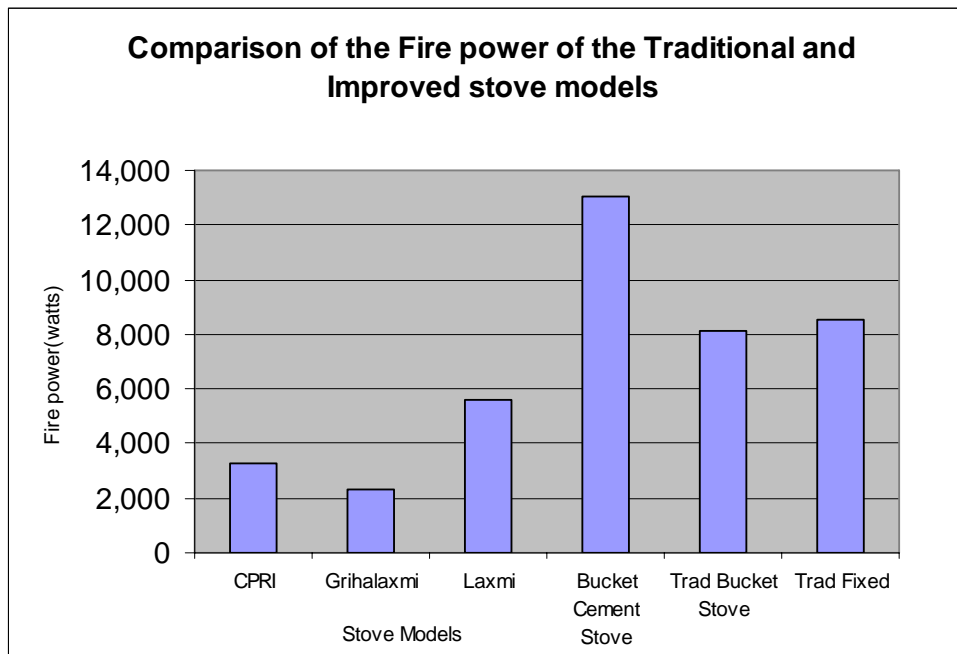
\* Thermal Efficiency is the ratio of the work done by heating and evaporating water to the energy consumed by burning wood or any other fuel..

**Fig4: Comparison of the Temperature corrected Fuel Consumption**



\* Specific Fuel Consumption= Fuel required to produce unit output (boiling water). \* Temp corrected fuel consumption= This corrects specific fuel consumption to account for the differences in initial water temperatures.

**Fig5: Comparison of the firepower**



\* Fire power= This is the ratio of the fuel energy consumed by the stove per unit time. It tells the average power output of the stove (in Watts) during high power test.

**Discussion:** The above mentioned stove models were tested for performance using wood as the fuel. In case of the bucket stove, coal briquettes and wood were used. The results showed that on an average the CPRI cast iron stove, the Grihalaxmi cement stove and the 2 pot Laxmi stove with chimney performed the best having the lowest burning rate and least fuel consumption. The time taken to boil 2.5 litres of water was the least in these three stoves. The results of the cement lined bucket stove are incorrect since the stove was freshly made and damp.

Based on the results of the analysis of the Water Boiling Tests (WBT) done on the above mentioned models, the stoves may be graded as follows in order of their performance

1. Grihalaxmi
2. CPRI Cast Iron Portable stove
3. Laxmi
4. Traditional single pot fixed mud stove ( generally used in Khalbari, Shalimar and Panchur)
5. Portable bucket stove lined with mud(generally used in Panchur, Coalberth).This stove was expected to perform much better but the fuel used in these stoves is coal briquettes made with a mixture of mud and coal in which the proportion of mud is very high thus lowering the calorific value of the fuel.
6. Portable bucket stove lined with cement. This stove was made by the ARTI technician with the objective of making a durable model of the bucket stove but it

has not been graded, not because its performance in WBT tests were unsatisfactory but because it was too damp and was as a result too smoky and required a long time to boil and thus required extra fuel. It was thus impossible to judge this model but it will be taken up for further testing later when the stove is totally dry.

Based on the performance of these stoves it was decided that the further tests on the performance of the stoves with various fuels commonly used in the urban slums of Kolkata, would be carried out only on the CPRI and the Grihalaxmi model. Laxmi model was rejected for the study for practical reasons, because it is too big and bulky and cannot fit into the tiny slum establishments.

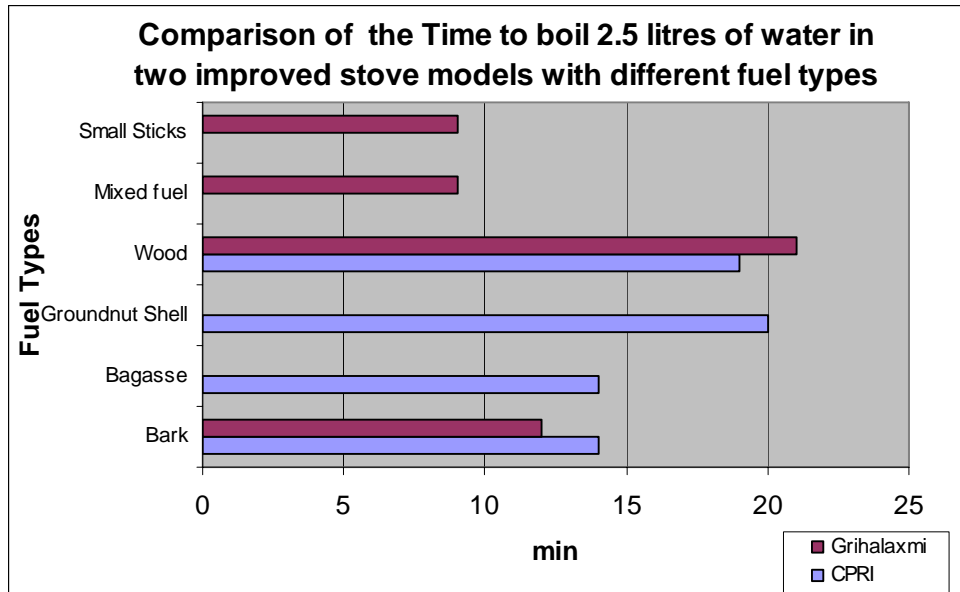
### **Task 3: Comparison of stove performance of two improved cookstoves (CPRI & Grihalaxmi) based on fuel types.**

The different fuels that were selected for the study were:

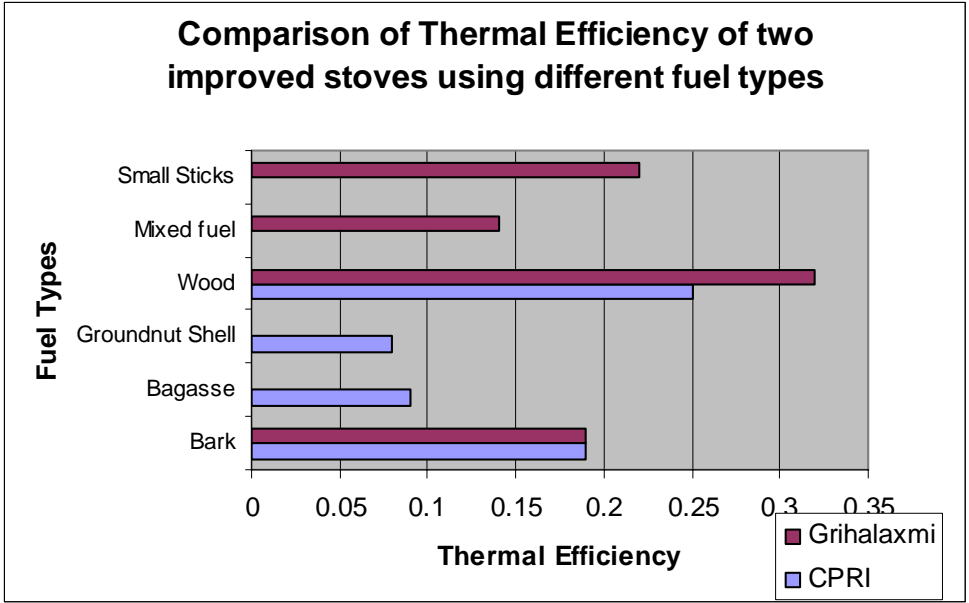
1. Small Sticks commonly used in Panchur
2. Mixed fuel (sticks, sawdust, wood, bark) commonly used in Khalbari.
3. Wood
4. Groundnut shell
5. Bagasse
6. Bark of trees commonly used in Khalbari.

No tests were carried out with the coal briquettes because CPRI and the Grihalaxmi are wood burning stove and the portable bucket stove is suitable for burning briquettes.

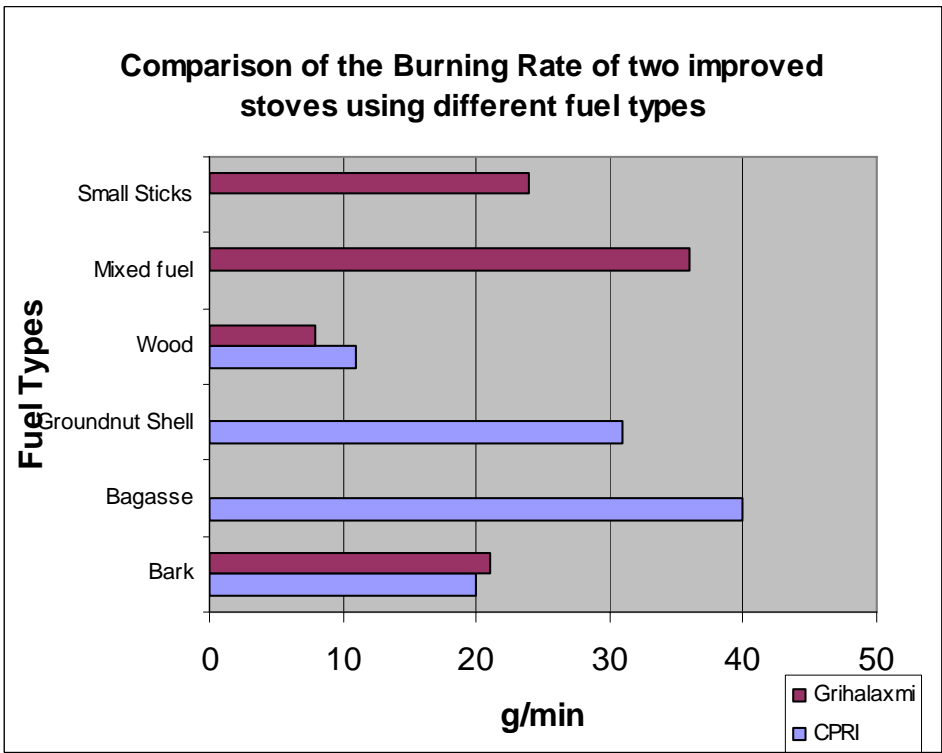
### **Fig6: Comparison of the Boiling time**



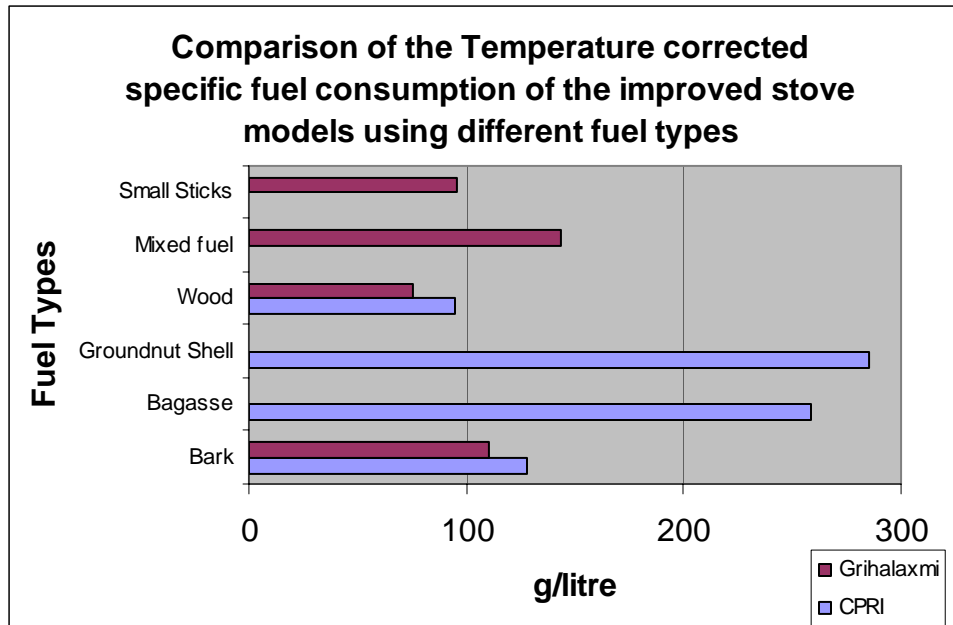
**Fig7:Comparison of the Thermal Efficiency**



**Fig8: Comparison of the burning rate**



**Fig9: Comparison of the Temperature corrected Fuel Consumption**



**Results:** Based on the results of the analysis of the Water Boiling Tests (WBT) done on the above mentioned models with the above mentioned fuel types, the fuels may be graded as follows in order of their performance.

1. Wood
2. Bark
3. Small sticks
4. Mixed fuel
5. Groundnut shell
6. Bagasse.

**See Appendix 1**

**Discussion & Recommendations:** The fuel and stove combination that showed the most consistent and versatile performance is the Grihalaxmi. The CPRI is equally good but since it is cast iron there is a chance that the beneficiaries may sell off the stove for monetary benefits. The Grihalaxmi is available in both mud and cement models. The entrepreneurs have been trained to make these stoves from the mould.

Based on stove performance with various fuels Grihalaxmi is being recommended for Shalimar, Khalbari and Panchur. In Panchur, Laxmi may also be installed as they have access to wood and small sticks and the houses are bigger and more spacious. The reasons for the recommendation of Grihalaxmi are as follows:

1. It is a versatile stove and can be used with various fuel combinations.
2. It is a single pot fixed stove almost similar in size to the ones currently being used by the slum dwellers
3. It is cheap so affordable to the poor people.
4. If necessary a chimney can be fitted into the stove (this can be decided from the emission results).

5. Manufacturing of Grihalaxmi may be done by the stove entrepreneurs trained by ARTI thus providing them income.

The areas which use coal briquettes need to increase the proportion of coal in the mud coal combination and they may try out the following different combinations.

1. Coal and rice starch or any other starchy material.
2. Coal, cowdung and mud
3. Coal and any other starchy material like the waste flour from the flour mills.

Since the coal powder is available for free they may be advised to try to out these above mentioned combinations for better stove performance.

More detailed discussions and recommendations will be given based on the emission results. which will be submitted in the second report.